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A Coupled-Cavity Slow-wave Structure for Sheet-Beam Devices

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Abstract: *We describe a novel sheet-beam slow-wave interaction structure based on a coupled-cavity geometry.*

Keywords: sheet-beam; slow-wave structure.

Introduction

There is at present considerable interest in sheet beam device geometries to increase the beam power available for linear beam amplifiers while lowering cathode current density and magnetic field requirements. Sheet-beam configurations are of particular interest for high-frequency applications as they provide significantly higher current than round-beam geometries in a simpler single-beam configuration. Here we describe a novel sheet-beam slow-wave interaction structure based on a coupled-cavity geometry.

Sheet-beam structure

Our slow-wave structure for sheet-beam operation is derived from the double-staggered ladder coupled-cavity geometry [1], and retains many of its desirable characteristics. The new sheet-beam structure is shown in Figure 1, and is enclosed on four sides by metal walls. An odd number of coupling slots connect consecutive rectangular cavities in the waveguide structure. The slots are distributed evenly around the periphery, including one slot along a side wall, and the pattern is alternated so that consecutive sets of slots are offset, as in the traditional double staggered ladder structure.

Figure 2 shows the top half of a 3-slot geometry, such that the lower face represents a symmetry plane at the location of the sheet beam. The dispersion relation for this structure is very similar to that of the related round-beam structure for the same slot dimensions, except that higher-order modes having transverse structure appear as the beam tunnel width increases. By locating slots alternately at each side wall, the wave is capacitively coupled to the waveguide wall, and the axial interaction field is not short-circuited at the beam edges. This translates to uniform interaction impedance across the beam tunnel desirable for interaction with a sheet electron beam.

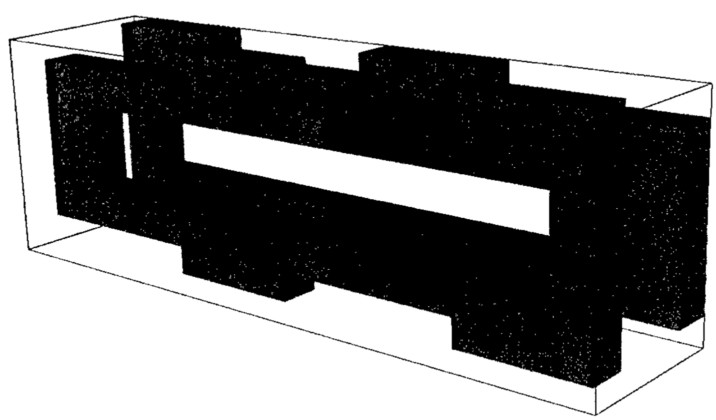

Figure 1. Isometric view of the two-cavity unit cell of the periodic structure, with 5 slots.

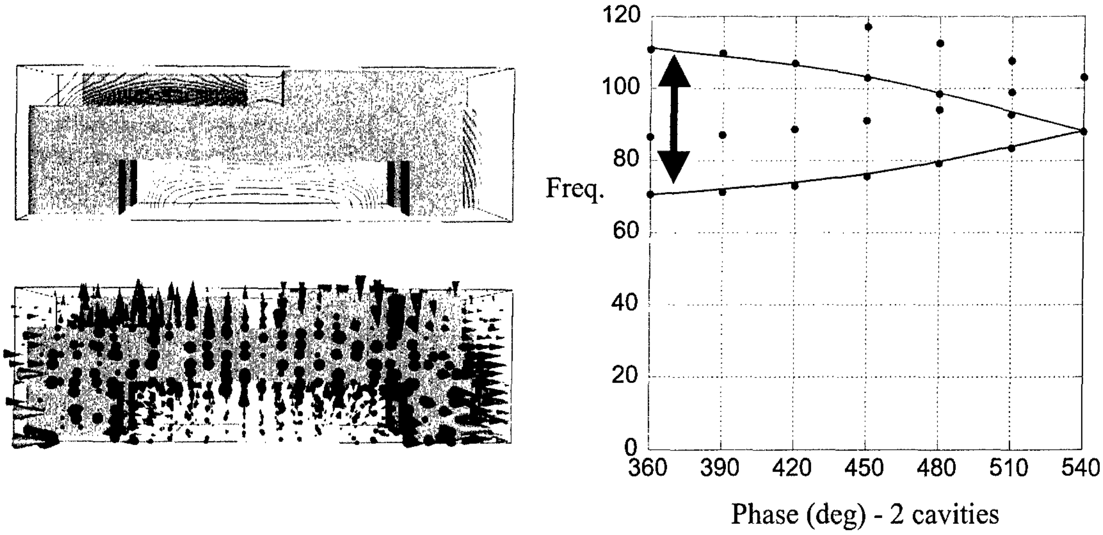

Figure 2. Sheet beam CC-TWT slow-wave structure (3 slots, upper half shown), showing the field structure for the pi-mode and the dispersion characteristics. The bandwidth for the fundamental transverse mode is approx. 40%.

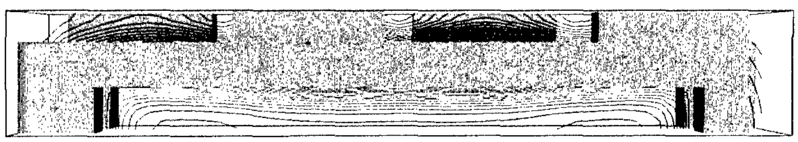

Figure 3. Sheet beam CC-TWT slow-wave structure (5 slots, upper half shown), showing the flat profile of the axial electric field across the structure

Figure 3 shows the operating mode field profile of a 5-slot structure, demonstrating the flat field profile across the beam. Due to differences in the geometry of the slots, particularly the end slots, it is necessary to adjust the structure dimensions to correctly match the slot frequencies in order to optimize the flatness of this field. Adjustment of the slot and cavity dimensions also allows sufficient control over the dispersion properties of the structure to match a low-voltage electron beam. We will describe the additional characteristics of this structure that make it attractive as the basis for high frequency amplifier development.

References

1. B.G.James, "Coupled-Cavity TWT Designed for Future Mm-Wave-Syatems," Microwave Systems News and Communications Technology, Vol 16, Dec. 1986.